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# Experimental Research on the Influence of Vibration on Fingers Mobility

*In many industrial activities the human body is exposed to vibrations transmitted through the hand-arm system. A long exposure to these vibrations can cause various health problems of blood vessels, nerves, muscles, bones, joints and upper limb [1]. This paper presents some considerations about the influence of vibration on finger joints mobility. I used a MediTouch system which consists of a motion capture device (an ergonomic glove) and a dedicated software.*

***Keywords**: MediTouch, ergonomic glove, finger, joints, mobility*

## 1. Introduction

Hand-transmitted or hand-arm system vibration, are the mechanical vibrations occurring in the technological process due to the different vibrating tools and enter in the human body through the operator's hand. Many industrial activities exposed the human body to such hazards by the tools used. [1]

There are opinions that state that the various diseases or injuries of bones and joints are not caused by exposure to vibration phenomena but by the hard work done over a long period of time and the ageing of the person. However, medical investigations revealed cysts in the muscles and joints, and research has found that certain changes in the characteristics of hand bones, joints knees and elbows can be attributed to prolonged exposure to vibration. [1]

For example, Dupuytren's contracture although it has been reported to the workers in the mining - working with the percussion tools (pneumatic hammers, etc.) - can be seen as an effect of long-term and high effort. Association between this disease and vibrations is still uncertain [2]. The same conclusions are valid for local bone or joint pain.

In EU countries such as Germany, France, Italy such problems are considered illnesses of the skeletal system and workers which use vibration equipment receive material compensation. [1]

The objective of this paper is to reveal some aspects of the influence of vibration on finger joint mobility.

## 2. Method

To determine the influence of vibration on finger joint mobility I used a MediTouch system which consists of a motion capture device (an ergonomic glove) and a dedicated software by which the data were processed (Figure 1).

**Figure 1.** MediTouch system

Experiments were carried out in Innovation Research Institute Labs of the University "Transilvania" of Brasov. Two subjects - no medical problems with the hand - were exposed to the same type of vibration:

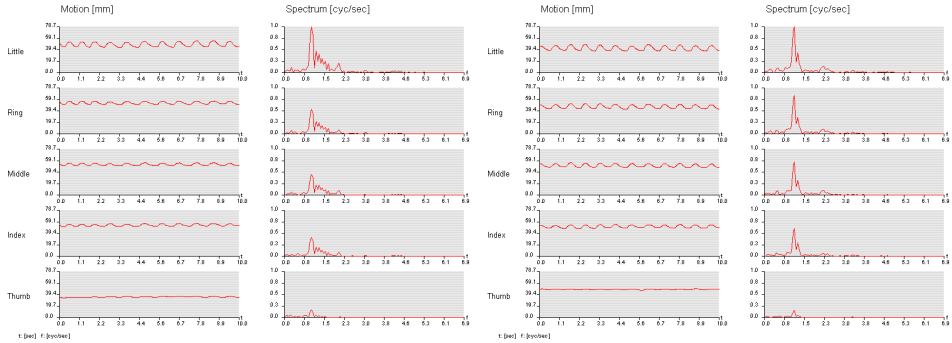
- ✓ Subject A - male, 43 years old, right – handed;
- ✓ Subject B - male, 16 years old, left – handed.

Each of the two subjects performed three sets of movements (flexion and extension of fingers) for each hand. This type of movement was repeated and after exposure to vibration (Figure 2).

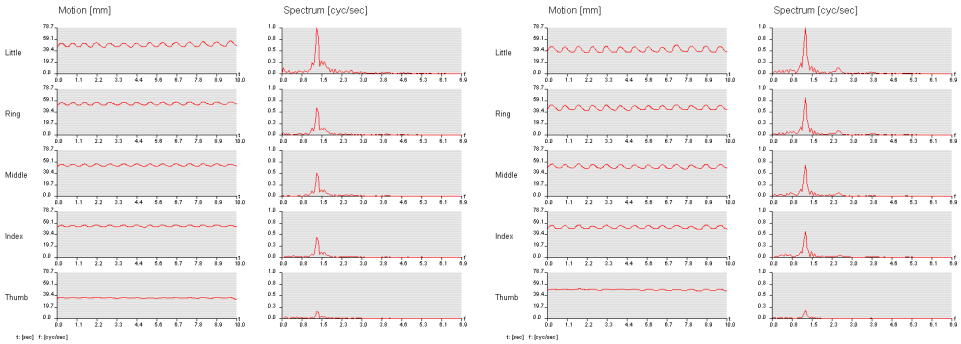
**Figure 2.** Subjects in tests

## 3. Analysis

During the experiment, motion [mm] and spectrum [cyc/sec] were recorded, and they showed Maximum Frequency Energy and Maximum Range of Motion for each of the five fingers (time period was 10 seconds).




a) Reference – test 1 b) After-vibration – test 1

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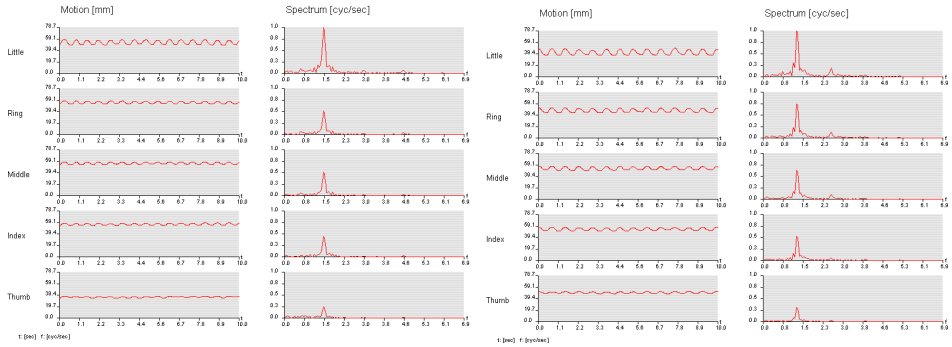
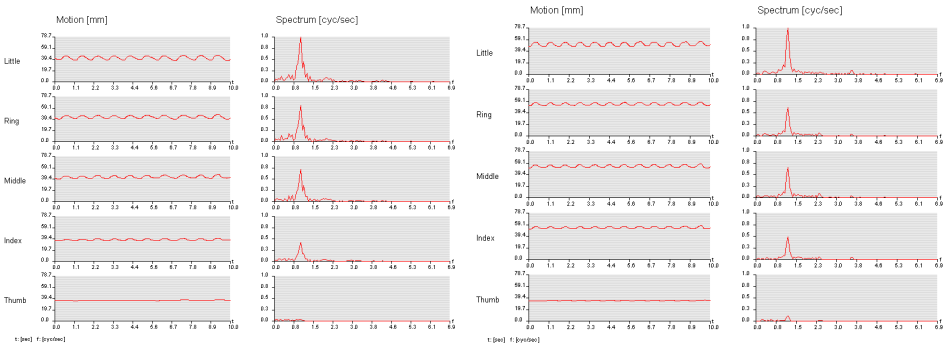



e) Reference – test 3 f) After-vibration – test 3

**Figure 3.** Subject A – right-hand




a) Reference – test 1

b) After-vibration – test 1

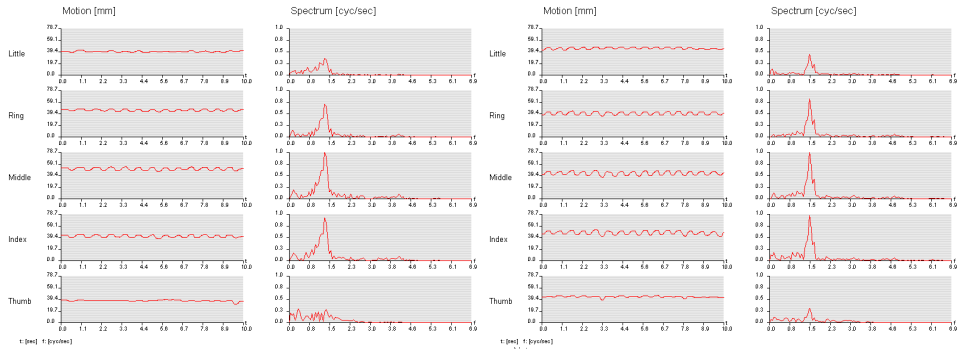
c) Reference – test 2

d) After-vibration – test 2

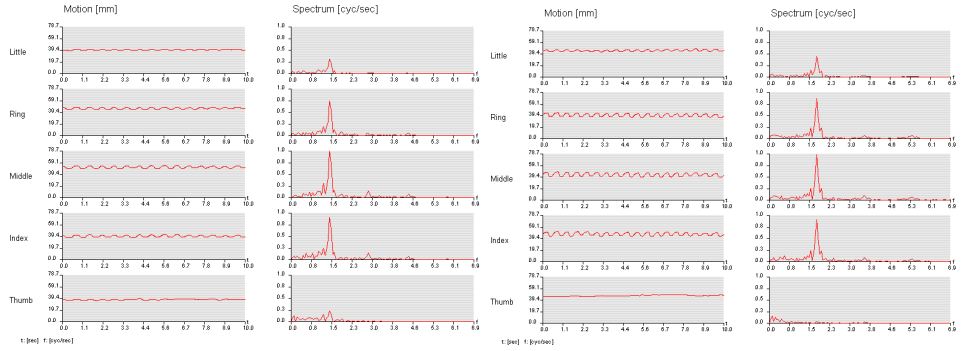
e) Reference – test 3

f) After-vibration – test 3

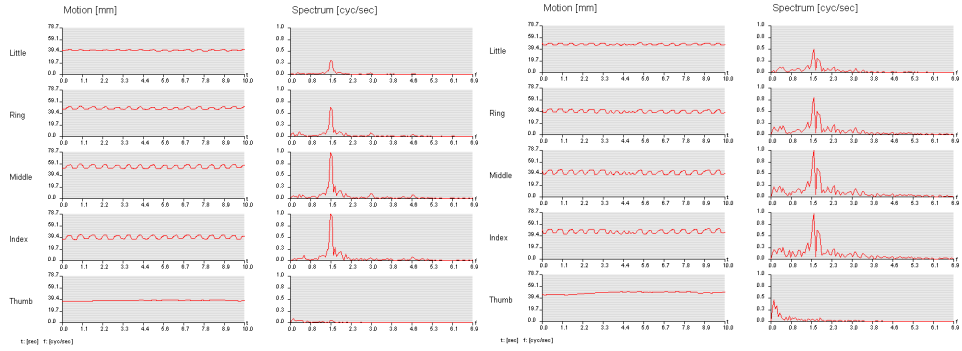
**Figure 4.** Subject A – left-hand




a) Reference – test 1 b) After-vibration – test 1

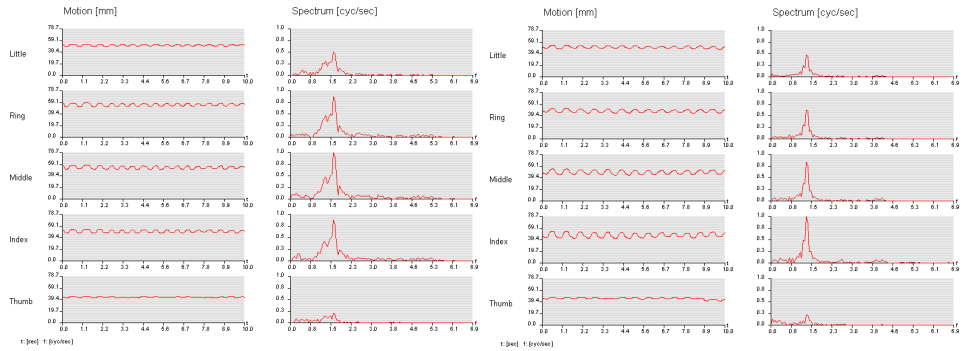



c) Reference – test 2 d) After-vibration – test 2

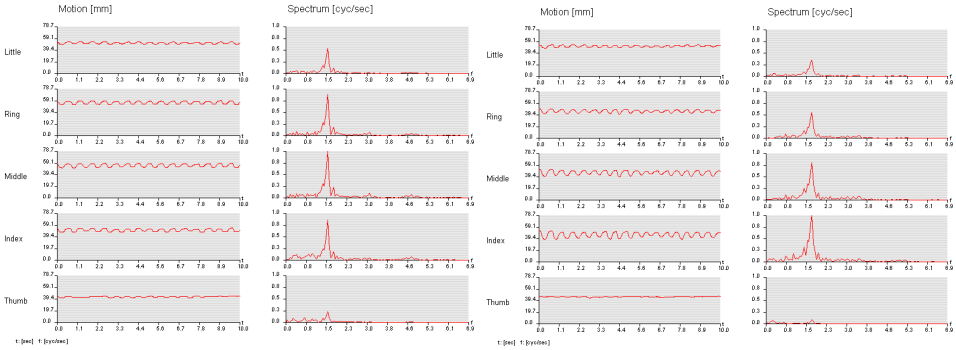



e) Reference – test 3 f) After-vibration – test 3

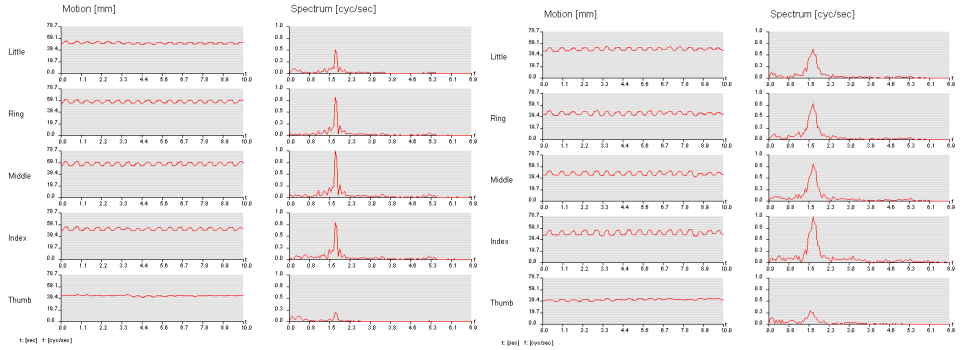
**Figure 5.** Subject B – right-hand




a) Reference – test 1 b) After-vibration – test 1




c) Reference – test 2 d) After-vibration – test 2




e) Reference – test 3 f) After-vibration – test 3

**Figure 6.** Subject B – left-hand

## 4. Conclusion

A first observation - that falls outside the object of this experiment - is that I can identify which of the subjects is right-handed and which is left-handed; the thumb motion diagrams especially highlight this. Motion graphs look irregular for the right hand fingers (for left-handed) and vice versa. The figures 4 c) and 5 e) shows that the thumb movement is practically non-existent.

In Tables 1 and 2, I present average values of the three tests (for the Max. Freq. Energy and Max. ROM):

**Table 1 (Subject A)**

| Fingers | Befor vibration | | | | After vibration | | | |
|---|---|---|---|---|---|---|---|---|
| | Max. Freq. Energy [cyc/sec] | | Max. ROM [mm] | | Max. Freq. Energy [cyc/sec] | | Max. ROM [mm] | |
| Little | 1,3 | 1,2 | 10,43 | 10,9 | 1,26 | 1,26 | 12,2 | 8,8 |
| Ring | 1,3 | 1,2 | 5,4 | 9,76 | 1,26 | 1,26 | 9,0 | 6,86 |
| Middle | 1,3 | 1,2 | 4,73 | 8,7 | 1,26 | 1,26 | 8,03 | 6,93 |
| Index | 1,3 | 1,2 | 4,76 | 5,26 | 1,26 | 1,26 | 6,86 | 5,56 |
| Thumb | 1,3 | 0,96 | 3,26 | 3,93 | 1,26 | 1,26 | 3,03 | 2,36 |
| | Right hand | Left hand | Right hand | Left hand | Right hand | Left hand | Right hand | Left hand |

**Table 2 (Subject B)**

| Fingers | Befor vibration | | | | After vibration | | | |
|---|---|---|---|---|---|---|---|---|
| | Max. Freq. Energy [cyc/sec] | | Max. ROM [mm] | | Max. Freq. Energy [cyc/sec] | | Max. ROM [mm] | |
| Little | 1,43 | 1,66 | 3,3 | 4,96 | 1,63 | 1,6 | 5,13 | 6,83 |
| Ring | 1,43 | 1,66 | 4,9 | 6,6 | 1,63 | 1,6 | 8,03 | 8,86 |
| Middle | 1,43 | 1,66 | 6,93 | 7,66 | 1,63 | 1,6 | 9,9 | 10,93 |
| Index | 1,43 | 1,66 | 6,86 | 6,8 | 1,63 | 1,6 | 9,36 | 12,6 |
| Thumb | 0,66 | 1,66 | 4,73 | 3,5 | 0,56 | 1,56 | 5,93 | 4,96 |
| | Right hand | Left hand | Right hand | Left hand | Right hand | Left hand | Right hand | Left hand |

- ✓ Values 0,96 cyc/sec (Subject A, left hand, befor vibration) and 0,66 cyc/sec (Subject B, right hand, befor vibration) can highlight who is right-handed or left-handed;
- ✓ Right-handed subject (Subject A) shows the trend of increasing mobility after vibration for right hand finger joints and a decrease of mobility of the left hand finger joints (Max. ROM columns);

- ✓ Left-handed subject (Subject B) shows the trend of increasing mobility after vibration for right hand and left hand finger (Max. ROM columns);
- ✓ For Subject A, a decrease of the Max. Freq. Energy for the right hand and a slight increase of the Max. Freq. Energy for left hand was reported;
- ✓ For Subject B, an increase of the Max. Freq. Energy for the right hand and a slight decrease of the Max. Freq. Energy for left hand was reported;

It highlights that there is a better functioning of joints subject B (for both hands) and a worse joint mobility for subject A (especially for the left hand). This can be correlated with subjects age.

These are partial conclusions. For the future - to confirm and improve this conclusions - I propose to extend research on a larger group of subjects, some of them with medical problems with the hands.

**Acknowledgement**

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